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Exploration and Practice of Modularized Teaching Mode for Modern Communication Technology Specialty in Higher Vocational Colleges

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Abstract: With the ongoing upgrading and structural adjustments in the information and communication industry, professional development in higher vocational education has fallen behind industrial advancements. The teaching faculty lags behind industry requirements, and student skill training does not fully meet the technical demands of enterprises. This paper explores the modularized teaching mode and methodology for modern communication technology through a cooperative professional teaching team. By analyzing enterprise needs, the study aims to enhance and restructure the modular curriculum system, cultivate a modular teaching team, develop modular teaching resources, and establish training bases both on and off campus to support modular teaching. These efforts will drive reforms in the modular teaching mode and methods for modern communication technology, align with industrial upgrades, improve talent training quality, strengthen social service capabilities, and meet the demands of regional economic development.

Keywords: Modularization; Teaching mode; Division of labor and cooperation; Vocational competency orientation

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1. Research objectives of the modular teaching model

This study aims to develop a modular teaching model by building a collaborative teaching team and establishing a modular curriculum system based on "vocational competency orientation and integration of coursework, competition, and certification." Additionally, it seeks to implement an "X" certificate certification system, creating a "competency package"-style online and offline information-based teaching resource that reflects real-world communication engineering practices. A resource bank for verifying "X" skill-level certificates will also be developed. In alignment with market demands and enterprise job requirements, this study will construct a dual school-enterprise, loose-leaf, workpage-style teaching material system. The reform of the modular teaching mode will be actively explored [1], implementing the "one lesson, multiple

teachers; one teacher, multiple lessons" approach. Professional teaching team members will participate in the entire talent training process, with core module courses adopting a modular teaching approach [2]. Advanced technologies such as 5G, automatic identification, artificial intelligence, virtual reality, and the Internet of Things will be integrated into curriculum development and teaching reform. These efforts aim to enhance students' long-term career adaptability and professional development while steadily improving training quality and strengthening the contribution of vocational education to local industrial growth.

2. Research content of the modular teaching model

2.1. Overall framework

In view of the current situation of teaching reform in higher vocational colleges, the framework system of implementing the reform of modular teaching mode based on the division of labor and cooperation of teachers is shown in **Figure 1**.

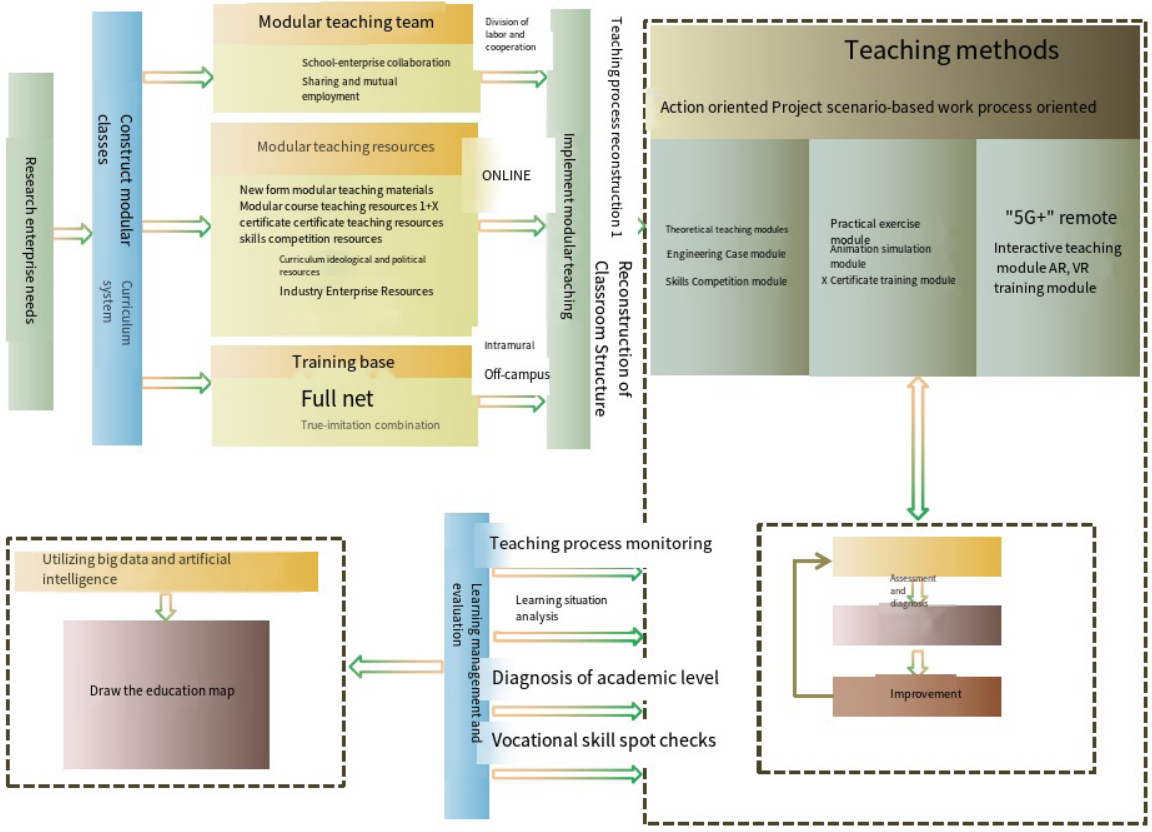

Figure 1. Overall framework of the research

2.2. Investigating enterprise needs and improving the modular curriculum system

Extensive research should be conducted to analyze typical enterprise job roles, summarize the vocational competencies required for various positions [3], and integrate them based on the complexity of these competencies [4]. This will facilitate the development of vocational competency-based modular courses [5].

The curriculum should emphasize moral cultivation, the integration of ethics and skills, and the application of knowledge through practice, thereby reinforcing the "three aspects of education." It should

incorporate ideological and political education with a focus on craftsmanship. For key enterprise roles, vocational competency training should be prioritized, aligning with the 1+X vocational certificate level standards and skills competition projects [6]. These elements should be embedded within the curriculum framework to establish a modular system that integrates vocational competency development, job-specific coursework, competition participation, and certification attainment [7-10]. The curriculum structure is illustrated in **Figure 2**.

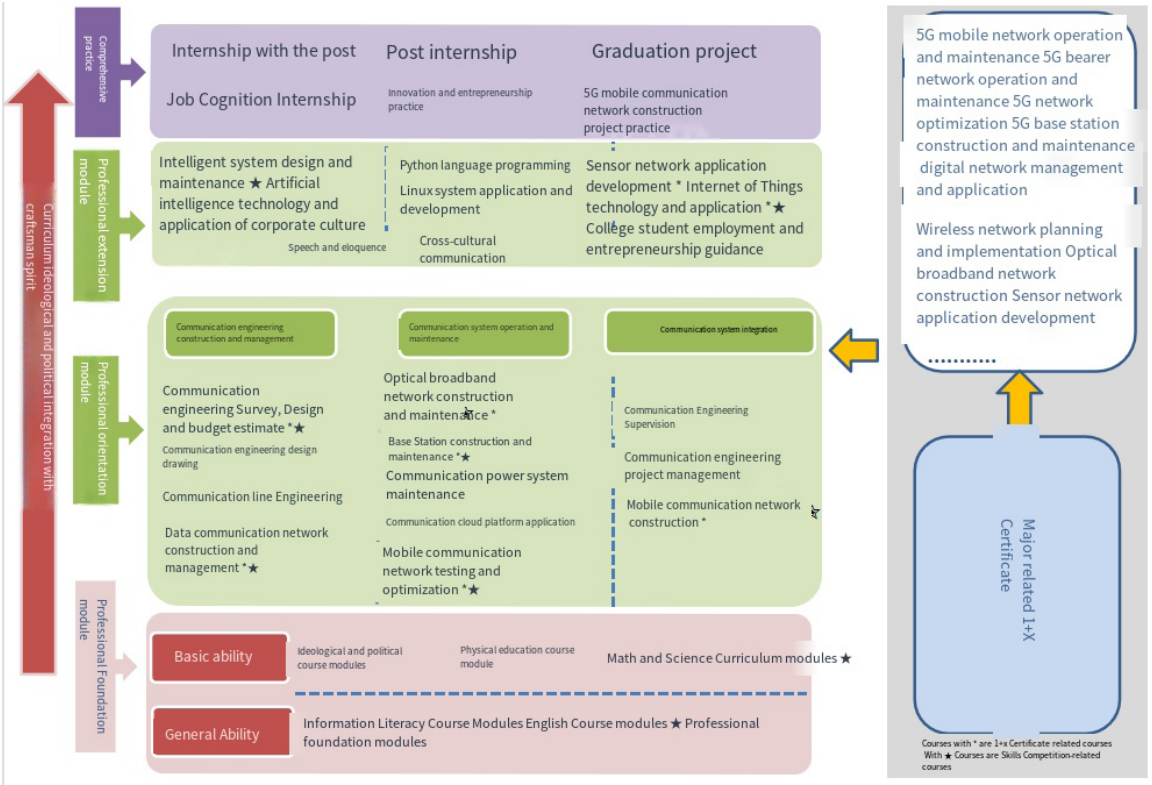

Figure 2. Modular curriculum system of "vocational ability orientation, post course competition certificate accommodation"

2.3. Establishing a strong foundation for modular teaching

To implement modular teaching effectively, it is essential to develop a dedicated modular teaching team, build modular teaching resources, and establish practical training bases both on and off campus.

2.3.1. Developing a modular teaching team

A modular teaching team [11] should be established to function within small collaborative groups. Industry executives, model workers, and master craftsmen should be engaged as industry mentors, while experienced enterprise professionals should be recruited as part-time instructors. Through school-enterprise collaboration, mutual employment, and resource sharing, the teaching team can be structured with clear divisions of responsibility.

The team-building project group is responsible for formulating team development plans, establishing management systems, implementing accountability mechanisms, and conducting performance evaluations. Meanwhile, the teaching capacity-building group will focus on researching and enhancing teaching methodologies, improving instructors' abilities in modular teaching design, integrating ideological and

political education, developing curriculum standards, conducting teaching evaluations, fostering teamwork, and applying information technology in education [12].

The curriculum development group will collaborate with enterprises to design professional training plans, refine the modular curriculum system and standards, integrate ideological and political education, align with the 1+X vocational skill level standards, and develop new teaching materials. Additionally, they will introduce high-quality courses from industry and enterprises and create modular curriculum resources supported by intelligent teaching environments.

The innovation and entrepreneurship service group will leverage the information and communication collaborative innovation platform to offer technical and training services. They will guide students in innovation, entrepreneurship, and skills competitions, encouraging participation in competitions at various levels.

2.3.2. Developing new modular teaching materials through school-enterprise collaboration and creating diverse teaching resources

To deepen the reform of the "Three Education" initiative, it is essential to promote school-enterprise collaboration in the development of teaching materials. Strengthening and improving the construction of vocational education resources will enhance the quality of talent cultivation, ensuring that teaching materials play a fundamental role in this process.

(1) Aligning vocational skills with industry needs through school-enterprise collaboration

Conduct in-depth research and analysis of enterprise positions and vocational skill requirements to identify the core tasks of each course. Actively involve enterprise technical experts, skilled craftsmen, and other professionals in the development of teaching materials. This approach ensures that content stays aligned with industry trends and talent demands, incorporating the latest technologies, processes, and industry standards in a timely manner. Teaching materials should be designed using task-driven and project-based approaches that integrate theory with practice while aligning with enterprise needs. The materials should authentically reflect the concept of work-study integration by extracting real-world work tasks from actual communication network projects. Additionally, teaching scenarios should be created in accordance with students' cognitive development and skill progression, following a structured approach from simple to complex tasks. Each scenario should correspond to a complete work process, fostering a comprehensive learning experience.

(2) Developing loose-leaf and workbook-style teaching materials

A series of modular teaching materials should be developed to cover the entire communication network. These materials must align with the growth trajectory of technical and skilled professionals, balancing theoretical knowledge with hands-on skill training. Additionally, they should emphasize the development of students' professional competencies while instilling values such as professionalism, responsibility, and craftsmanship. The content should be tailored to support professional program development, curriculum innovation, and the reform of teaching methods. For example, each study unit is divided into four parts: task sheet, information page, work page, and evaluation sheet.

(3) Leveraging "Internet + Vocational Education" to build modular teaching resources

To advance teaching reform and meet the development needs of "Internet + Vocational Education," new forms of three-dimensional resource construction should be explored. These efforts should include the compilation of modular teaching materials, the development of supplementary digital

resources, and the integration of information technology to enhance curriculum delivery. By incorporating ideological and political education elements, 1+X certification resources, and industry-enterprise insights, the teaching framework can effectively blend online and offline learning with theoretical and practical applications. The focus should be on cultivating students' comprehensive vocational abilities and further advancing the reform of teaching models to meet evolving industry demands.

2.3.3. Building training bases inside and outside schools to support modular teaching

The school training environment follows the "whole network, real-imitation combination" approach. Since 2013, a new generation of comprehensive information and communication training centers has been developed in phases, including the Communication Comprehensive Training Center, the Communication Innovation Design Training Room, the Communication Fiber Optic Cable Engineering Training Room, the Communication Extension Technology Comprehensive Training Room, and the Communication Engineering Survey and Design Training Room. Advanced equipment and systems have been introduced, such as the 5G mobile communication network deployment and optimization simulation system, 4G LTE network equipment, 4G LTE network simulation system, mobile communication network optimization system, mobile communication network optimization simulation system, communication VR system, triple-play integration simulation system, optical access equipment, optical transmission equipment, and data communication equipment. These training facilities encompass the entire mobile communication network, incorporating both real-world equipment and simulation systems. This integration of real and simulated components ensures the training environment meets the requirements of remote teaching.

To align with the evolving information and communication industry, continuous investment is made in developing additional practical training platforms, including a communication cloud platform and a communication engineering project management system.

Furthermore, multifunctional off-campus training bases are being established. Agreements have been signed with ZTE, Datang, the three major telecom operators, China ICT, Zhongtong No. 8 Bureau, and other enterprises to provide training in various areas, such as communication network construction and maintenance, communication network planning and optimization, communication engineering survey, design and budgeting, communication engineering project management, and communication application development. These bases support internships and graduation projects at different levels and in diverse roles.

Additionally, in collaboration with ZTE, an AI-powered online laboratory, Walnut, has been developed. This lab leverages a knowledge graph and big data-driven artificial intelligence platform to create an adaptive education and learning environment. It offers micro-professional certification and test modules to enhance students' overall professional competencies.

By integrating on-campus and off-campus training, real and simulated equipment, and online and offline resources, a comprehensive training base has been established to provide an optimal teaching environment for implementing modular teaching.

2.4. Implementing modular teaching

2.4.1. Reconstruction of the teaching process

Modular teaching is implemented by reconstructing the teaching process based on workflow principles, aligning with the current 5G whole-network construction and optimization workflow. This includes 5G base

station construction and maintenance, 5G bearer network construction and maintenance, 5G whole-network construction, and 5G network optimization. Taking 5G base station construction as an example, the process requires expertise in several key areas, including communication engineering survey design and budget estimation, communication engineering design drawing, communication line engineering, optical broadband network construction and maintenance, base station construction and maintenance, base station power supply system maintenance, communication engineering supervision, and communication engineering project management. The course group, with designated leaders and team members responsible for each module, collaborates to deliver modular teaching tailored to the needs of engineering construction.

2.4.2. Reconstruction of classroom structure

In reconstructing the classroom structure, a "one lesson, multiple teachers; one teacher, multiple lessons" approach is adopted. Depending on the characteristics of each task, diverse teaching methods—including action-oriented, project-oriented, scenario-oriented, and process-oriented approaches—are employed. The classroom structure integrates multiple modules, such as theoretical teaching, engineering case studies, skill competitions, practical operation drills, animation simulations, X-certificate practical training, 5G+ remote interactive teaching, and AR/VR-based practical training. Several modules work in tandem to ensure the effectiveness of modular teaching.

For example, in the sub-task "5G Base Station Survey, Design, and Budget Estimation," the theoretical teaching module, VR practical training module, practical operation drill module, skills competition module, and "5G+" remote interactive teaching module can be effectively combined to enhance learning outcomes.

2.5. Modular teaching method

This course is structured around real enterprise work processes, aligning with professional roles in communication system network operation, maintenance, planning, and optimization. The teaching and training environment emphasizes the values of labor and craftsmanship while integrating advanced German technology and a work-study approach for efficient instructional implementation. In terms of task execution, the "practice-learn-think" teaching method is adopted, ensuring a comprehensive learning experience. Advanced digital tools such as virtual simulations are leveraged to overcome teaching challenges.

Before class: Teachers release learning materials via the learning communication platform, set clear learning objectives based on course content, and assign learning tasks. The platform facilitates interaction between teachers and students, promoting engagement and guiding knowledge acquisition. Teachers adjust their instructional design based on student feedback.

In class: Teachers provide targeted feedback on common or challenging pre-class problems and guide students in mastering key concepts. For knowledge areas that require reinforcement, teachers offer focused explanations, utilizing animations and videos to aid understanding. Students develop problem-solving skills through structured activities. Effective digital tools enhance the teaching approach. After demonstrations and explanations, students use VR simulation software to complete assigned tasks, present their learning outcomes, and reinforce their active role in the learning process.

After class: The 1+X question bank is used to reinforce knowledge, while additional extension questions encourage students to apply newly acquired knowledge and skills, further refining their competencies.

2.6. Learning management and evaluation

A comprehensive learning management system should integrate independent learning with academic-level diagnostics. Through a cycle of assessment, diagnosis, and targeted improvement, students' learning progress and academic proficiency can be systematically analyzed. Intelligent online platforms such as the Superstar Learning Channel and classroom distribution systems facilitate the implementation and monitoring of the teaching process [13]. By addressing individual learning gaps through personalized training, the education graph dynamically updates as students progress, transforming learning from a passive to an active experience. After three years of study, a well-developed career competency graph is established, reflecting students' professional growth [14,15].

3. Key challenges in the modular teaching model

3.1. Reasonably adjusting the implementation plan of modular curriculum

To enhance the effectiveness of modular teaching, various instructional strategies should be employed, including virtual teaching and research rooms, online learning, group-based cooperative learning, and second-classroom activities. Collaboration with partner institutions and fostering student interaction are essential for completing modular tasks collectively. Practical learning components must be carefully structured to provide ample opportunities for hands-on experience, including laboratory practice, real-world simulations, and enterprise internships. These elements help reinforce students' operational skills and problem-solving abilities. By ensuring a seamless progression between courses within the module, a cohesive and interconnected curriculum is established, enhancing the overall efficiency of professional training.

3.2. Aligning with industry talent demands

To meet the evolving needs of industrial development, the latest advancements in technology, processes, and materials should be incorporated into the curriculum. Continuous updates to teaching projects and case studies ensure the relevance and forward-thinking nature of instruction. While foundational and common modules remain relatively stable, certain modules should be upgraded or newly developed to proactively respond to rapid industrial changes and emerging trends.

3.3. Designing hierarchical and classified teaching resources for personalized learning

Teaching resources should be developed based on learners' diverse characteristics, with a focus on systematic knowledge structures and resource interconnections. To accommodate different starting points and learning habits, resources must be tailored to support stratified instruction. The progressive and iterative nature of knowledge acquisition should be considered, with small-scale learning units gradually integrated into larger, more comprehensive modules. Additionally, content should be organized according to multiple logical frameworks, establishing a multi-dimensional, searchable resource system that supports personalized learning pathways.

4. Conclusion

The modular teaching reform in the modern communication technology major follows a results-oriented "tree" model. With the goal of improving teaching quality and talent development, this approach identifies key

drivers of modular teaching reform and their interrelations. The "roots" of the reform lie in thorough research and the construction of a well-structured modular curriculum. The "trunk" represents the reconstruction of teaching processes and classroom dynamics. The "soil" comprises collaborative teaching efforts, the development of modular resources, and the establishment of integrated training bases within and beyond the university. The "temperature and humidity monitoring" aspect refers to teaching management and evaluation, ensuring that all elements work in coordination. Through this structured approach, modular teaching reform yields fruitful outcomes, enhancing both education quality and student competency.

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Disclosure statement

The authors declare no conflict of interest.

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